PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP2008/067402	12.12.2008	21.12.2007

International Patent Classification (IPC) or both national classification and IPC
INV. G05F3/30

Applicant
ANALOG DEVICES, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	see form PCT/ISA/210	Arias Pérez, Jagoba Telephone No. +31 70 340-4194

Form PCT/ISA/237 (Cover Sheet) (April 2005)

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material:

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing:

      ☐ contained in the international application as filed.

      ☐ filed together with the international application in electronic form.

      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	3-5,7-15,18
	No:	Claims	1,2,6,16,17
Inventive step (IS)	Yes:	Claims	3-5,7-15,18
	No:	Claims	1,2,6,16,17
Industrial applicability (IA)	Yes:	Claims	1-18
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V.

1. The following documents (D) are referred to in this communication; the numbering will be adhered to in the rest of the procedure:

   D1: US 2006/038608 A1 (KATSUMI OZAWA) 23 February 2006

2. The application does not meet the requirements of Article 6 PCT, because claims 1, 17 and 18 are not clear.

2.1. Although claims 1, 17 and 18 have been defined as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and/or in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

In order to overcome this objection, it would appear appropriate to file an amended set of claims defining the relevant subject-matter in terms of a single independent claim in each category followed by dependent claims covering features which are merely optional.

2.2. Claim 1 defines a bandgap reference circuit as comprising "at least one transistor device driven by the output of the first amplifier for providing a PTAT current". However, in all embodiments available in the description (see figures 3 to 5) the first amplifier drives at least two transistors (M1 and M2 in figure 3 and M1, M2 and M8 in figures 4 and 5). The reason for this is that the first transistor (M1) is used to allow the PTAT current coming from R1 flow and the other transistors (M2 and M8, where available) are used for copying this PTAT current. Thus, the current summing circuit does not interfere with the creation of the PTAT current (see last paragraph of page 5). As there is no hint in the original application as

how the same technical effect can be achieved with only one transistor device, the claim is not supported by the description. In order to overcome this objection, the bandgap reference circuit should comprise "at least two transistor devices".

2.3. In claim 17, the current summing node is defined to be "provided at the output of the first amplifier". However, according to the description (see figure 3), the summing node (I Sum) is not provided at the output of the first transistor, but at the inverting input of the second amplifier (and the drain of transistor M2). This contradiction should be corrected.

2.4. Claim 18 is not supported by the description as it does not include all the features, which are essential for the invention to work. According to the description, the circuit in the present application solves the problem of generating temperature independent currents and voltages using a low supply voltage (see page 3, lines 11 to 12). To solve this problem, the circuit comprises (see figure 3) a feedback circuit having a first amplifier (A1), a second amplifier (A2), two MOS transistors (M1 and M2) and two resistors (R1 and R2), interconnected to:

a) generate a PTAT current across the first resistor (R1) by means of the negative feedback of the first amplifier (A1);

b) direct said PTAT current so that it flows through the first MOS transistor (M1);

c) replicate the CTAT voltage by means of the second amplifier (A2) so that the first and second MOS transistors (M1 and M2) behave as a current mirror having their gates interconnected and their drains at the same voltage and so that a CTAT current flows through the second resistor (R2; see page 5 last paragraph).

d) sum the PTAT current coming from the second MOS transistor (M2) and the CTAT current flowing through the second resistor (R2) in a summing node (I Sum).

Although the bandgap reference circuit defined in claim 18 contains all the necessary electronic parts to build the circuit shown in figure 3, it does not contain

all the essential features defining how these electronic parts should be interconnected, as the second amplifier (A1) is only defined to replicate the CTAT voltage and not to replicate the PTAT current through the second MOS transistor (M2) and the first MOS device (M1) is defined to be configured as an "inverter", and not as the master transistor of a current mirror. These essential features should be inserted in claim 18 in order for said claim to be supported by the description.

2.5. In claim 1, the acronyms "PTAT" and "CTAT" have been used without having been previously defined. The claims should be self-contained and not unnecessarily rely on the description for their interpretation (Rule 43(6) EPC) and therefore, all the acronyms should be adequately defined (PTAT as "proportional-to-absolute-temperature and CTAT as "complementary-to-absolute-temperature).

A similar objection applies to claims 17 and 18.

3. The present application does not meet the requirements of Article 33(2) PCT, because, with respect to document D1, the subject-matter of independent claims 1 and 17 is not new.

Document D1 (see in particular figure 1 and accompanying text) discloses a bandgap reference circuit operable at low supply voltages (see paragraph [0010]). The bandgap reference circuit of D1 comprises a first amplifier (see rightmost operational amplifier in figure 1) having an inverting input (-), a non-inverting input (+) and an output and first and second bipolar transistors (EA1 and EA2) operable at different current densities (see the different transistor areas) and coupled to the inputs of the first operational amplifier. The first and second transistors are connected to generate a proportional to absolute temperature (PTAT) current through a first load device (resistor connected to the emitter of EA2), indicative of the difference between the base-emitter voltages of the first and second transistors. The first amplifier drives at least one transistor (see the three MOS transistors connected to the output of the first amplifier) for providing a PTAT current.

The circuit of D1 further comprises a second amplifier (see leftmost operational amplifier) coupled to the first amplifier (both amplifiers have their non-inverting

inputs interconnected) such that a complementary to absolute temperature (CTAT) voltage provided at the input of the first amplifier is replicated in the inputs of the second amplifier, the output of the second amplifier being connected to the first and second bipolar transistors. The second amplifier is further connected to a second load device (the resistor connected between the inverting input of the amplifier and ground) to generate a CTAT current equivalent to the CTAT voltage.

The circuit of D1 further comprises a summing node (VBG) , where in the CTAT current and the PTAT current are summed to provide a constant current output of the circuit.

Hence D1 discloses in combination all technical features of claims 1 and 17, whose subject-matter is therefore not new.

4. Dependent claims 2, 6 and 16 do not contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of Article 33(2) and (3) PCT regarding novelty and inventive step.

4.1. The additional features of claims 2 are known from D1 (see figure 1), where the first amplifier controls two MOS transistors, and where the PTAT current is provided by the drain of the second MOS transistor. Those of claims 6 are also known from D1 (see current mirrors in figure 3).

4.2. The features added by claim 16 are known from D1 (see figure 1), where the first and second transistors (EA1 and EA2) are bipolar.

5. For the sake of completeness the following minor deficiencies are mentioned:

5.1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the document D1 is not identified in the description and the relevant background art disclosed therein is not at least briefly discussed.

5.2. Contrary to the requirements of Rule 6.3(b) PCT, the independent claims are not properly drafted in the two-part form, with those features which in combination are part of the closest prior art (cf. document D1) being placed in the preamble.

5.3. No reference signs in parentheses have been inserted in the claims to increase their intelligibility (Rule 6.2(b) PCT). This applies to both the preamble and characterising portion.

6. Because of the reasons stated in sections 1 to 5 above, claims 1, 2, 6, 16 and 17 are not allowable. However, in view of the available prior art, it seems that if the independent claim 18 were clarified to describe the feedback circuit shown in figure 3 (as indicated in section 2.4 above), the resulting claim would be new and inventive.

Possible steps after receipt of the international search report (ISR) and written opinion of the International Searching Authority (WO-ISA)

General information	For all international applications filed on or after 01/01/2004 the competent ISA will establish an ISR. It is accompanied by the WO-ISA. Unlike the former written opinion of the IPEA (Rule 66.2 PCT), the WO-ISA is not meant to be responded to, but to be taken into consideration for further procedural steps. This document explains about the possibilities.
Amending claims under Art. 19 PCT	Within 2 months after the date of mailing of the ISR and the WO-ISA the applicant may file amended claims under Art. 19 PCT directly with the International Bureau of WIPO. The PCT reform of 2004 did not change this procedure. For further information please see Rule 46 PCT as well as form PCT/ISA/220 and the corresponding Notes to form PCT/ISA/220.
Filing a demand for international preliminary examination	In principle, the WO-ISA will be considered as the written opinion of the IPEA. This should, in many cases, make it unnecessary to file a demand for international preliminary examination. If the applicant nevertheless wishes to file a demand this must be done before expiry of 3 months after the date of mailing of the ISR/WO-ISA or 22 months after priority date, whichever expires later (Rule 54bis PCT). Amendments under Art. 34 PCT can be filed with the IPEA as before, normally at the same time as filing the demand (Rule 66.1 (b) PCT). If a demand for international preliminary examination is filed and no comments/amendments have been received the WO-ISA will be transformed by the IPEA into an IPRP (International Preliminary Report on Patentability) which would merely reflect the content of the WO-ISA. The demand can still be withdrawn (Art. 37 PCT).
Filing informal comments	After receipt of the ISR/WO-ISA the applicant may file informal comments on the WO-ISA directly with the International Bureau of WIPO. These will be communicated to the designated Offices together with the IPRP (International Preliminary Report on Patentability) at 30 months from the priority date. Please also refer to the next box.
End of the international phase	At the end of the international phase the International Bureau of WIPO will transform the WO-ISA or, if a demand was filed, the written opinion of the IPEA into the IPRP, which will then be transmitted together with possible informal comments to the designated Offices. The IPRP replaces the former IPER (international preliminary examination report).
Relevant PCT Rules and more information	Rule 43 PCT, Rule 43bis PCT, Rule 44 PCT, Rule 44bis PCT, PCT Newsletter 12/2003, OJ 11/2003, OJ 12/2003